

BLANK FIELD X-RAY SOURCES

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ABSTRACT. The X-ray sky is not as well known as is sometimes thought. We report on our search of minority populations (Kim & Elvis 1999). One of the most intriguing is that of ‘blank field sources’, i.e. bright ROSAT sources ($F_X > 10^{-13}$ erg cm⁻² s⁻¹) with no optical counterpart on the Palomar Sky Survey (to O=21.5) within their 39'' (99%) radius error circle.

The nature of Blank Field sources is unknown: no known extragalactic population has such extreme X-ray to optical ratios ($f_X/f_V > 60$). Moreover blank field source tend to have much flatter PSPC spectra compared to radio-quiet AGN. Both properties suggest obscuration.

‘Blank field sources’ could be: Quasar-2s, low-mass AGNs, isolated neutron stars, high redshift clusters of galaxies, failed clusters, AGNs with no big blue bump. Identification with any of these populations would be an interesting discovery.

1. Sample Selection

Blank Field Sources (BFS) are extreme X-ray loud objects; the non detection of an optical counterpart down to the Palomar limit (O=21.5) imply $f_X/f_V > 60$.

To isolate ROSAT BFS we selected the ROSAT PSPC pointed observation sources with $f_x > 10^{-13}$ erg cm⁻² s⁻¹ and with no optical counterparts in the digitized sky surveys. We used all the sources from the WGACAT (White, Giommi & Angelini 1994) that were: (1) well-detected; (2) at high Galactic latitude ($|b| > 20^\circ$); (3) lay within the ‘inner circle’ of the PSPC (for their smaller positional uncertainty). We then used the APM digitization of the Palomar and UK Schmidt sky surveys (McMahon & Irwin, in preparation), via the WWW, to find sources with no optical counterpart within the 99% X-ray position circle ($r \sim 39''$). Due to a problem with rev 0 images used for WGACAT (Giommi, Angelini & Cagnoni, private communication 1999) $\sim 35\%$ of the BFS had wrong coordinates. We quote here the correct positions based on rev 2 version (from the Galpipe catalog) of ROSAT data. The total sample consists of 16 sources.

2. Nature of Blank field Sources

BFS nature is still mysterious: no known extragalactic population, including normal quasars, AGNs, BL Lacertae objects, normal galaxies and clusters of galaxies, can reach such an extreme f_X/f_V (see Maccacaro et al. 1988’s nomograph).

The unusually large f_X/f_V ratio, however, is not the only strong peculiarity of this class

of sources. X-ray colors reveal other interesting properties: BFS tend to have flatter PSPC spectra, compared to radio-quiet AGNs, in both the soft (0.1-0.8 keV) and the hard (0.9-2.4 keV) PSPC range.

No known source has such an extreme hard distribution in the α_S - α_H plane (Fiore et al., 1998, Nicastro, Elvis & Fiore 1998): Galactic X-ray sources have usually very steep PSPC spectra, which in term of PSPC colors means α_S and α_H greater than 2; normal galaxies and/or cluster of galaxies have thermal spectra with typical temperature of 1 keV and are generally distributed within a region of flat α_S and quite steep α_H ; radio-quiet and radio-loud type 1 AGN are well described by a single power law in the PSPC range and so lie in the central region of the $\alpha_S - \alpha_H$ diagram; finally Seyfert 2, with their heavily absorbed intrinsic X-ray continua, have α_S and α_H typical of normal galaxies (the contribution from the host galaxy emerging in the soft X-ray band).

The still open possibilities regarding the nature of BFS are:

- 1) - Quasar 2s: high luminosity, high redshift, heavily obscured quasars, the bright analogs of the well known Seyfert 2s;
- 2) - low mass Seyfert 2: that is AGNs powered by a low mass obscured black hole (i.e. obscured Narrow Line Seyfert 1);
- 3) - high redshift clusters of galaxies;
- 4) - failed clusters: (Tucker et al. 1995) in which a large overdensity of matter has collapsed but has not formed galaxies;
- 5) - AGNs with no big blue bump.

The identification of BFS with any of these would be an important find.

The faintness of their optical counterparts and the flatness of their PSPC spectra can be, in cases (1) and (2), due to the effect of the intrinsic absorption.

For all the BFS we obtained optical imaging in R and K to R=22 (this corresponds to B~23.5 for a galaxy) and K=20 and 5 out of 16 sources show red (R-K > 4) counterparts as expected from obscured AGNs and high z clusters of galaxies. We are applying to IR telescopes to obtain spectra of these 5 BFS with an interesting counterpart. The other 11 BFS do not show any obvious counterpart and their X-ray error circles show some sources (~ 5) expected as chance coincidence at these optical/IR magnitude limits.

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References

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